7. The process according to claim 1, wherein said body has a second type of conductivity, opposite to said first type of conductivity; further comprising the step of forming charge-balance columnar regions having said first type of conductivity through said body, both in said active portion and in said edge portion, and in particular through said guard region and said ring region; said step of forming columnar regions further comprising forming said surface layer and in particular surface extensions of said columnar regions on said first top surface and connection portions between said surface extensions.

8. The process according to claim 7, wherein said surface layer has a non-planar profile, and said surface extensions have a grooved, in particular substantially V-shaped, surface profile.

9. The process according to claim 7, wherein forming columnar regions comprises:

forming deep trenches inside said body; and

filling said deep trenches with semiconductor material via non-selective epitaxial growth so as to form said columnar regions inside said deep trenches and said surface extensions on said first top surface; said columnar regions having a doping level such as to substantially balance an opposite doping level of said body.

10. The process according to claim 9, wherein filling said deep trenches comprises supplying a gas containing said semiconductor material and a gas containing dopant ions of said first type of conductivity; supplying comprising varying, in particular increasing, a flow of said gas containing dopant ions.

11. The process according to claim 7, wherein said power device is a bipolar diode, and wherein said active region has in plan view a substantially rectangular shape and is surrounded by said ring region; a peripheral portion of said active region being connected in a continuous way to said guard region, and said columnar regions moreover traversing said active region.

12. The process according to claim 7, wherein said power device is a bipolar diode, and wherein said active region has in plan view the shape of parallel strips, and is surrounded by said ring region; peripheral strips of said active region being connected to said guard region, and said columnar regions each traversing a respective one of said strips.

13. The process according to claim 7, wherein said power device is a MOS device, and said active region comprises a plurality of body regions, each formed at least partially inside a respective surface extension of said columnar regions; further comprising forming gate structures between adjacent columnar regions, at least in part above said first top surface, and forming source regions of said second type of conductivity inside said body regions; the step of removing said connection portions in order to separate from one another said surface extensions and interrupting said wrinkled surface layer being moreover envisaged prior to formation of said gate structures.

14. The process according to claim 1, wherein said body has a second type of conductivity, opposite to said first type of conductivity, and said guard region forms with said body a bipolar diode, of which said guard region is the anode and said body is the cathode; further comprising forming, in a surface portion of said body, distinct from said active portion and from said edge portion, a contact region having said second type of conductivity, for contacting said cathode.

15. A semiconductor power device, comprising:

a body made of semiconductor material having a first top surface;

an active region having a first type of conductivity, set in the proximity of said first top surface and inside an active portion of said body; and

an edge-termination structure comprising a ring region having said first type of conductivity and a first doping level, set within a peripheral edge portion of said body and electrically connected to said active region,

wherein said edge-termination structure further comprises a guard region having said first type of conductivity and a second doping level, higher than said first doping level, set in the proximity of said first top surface and connecting said active region to said ring region; and wherein said body further has, at said peripheral edge portion, a second top surface set at a lower level with respect to said first top surface, and said guard region has inside it a step configured so as to connect said first and second top surfaces.

16. The device according to claim 15, wherein said guard region has a body portion having a given thickness and set in contact with said active region up against said first top surface, and an end portion having a thickness smaller than said given thickness, separated from said body portion by said step and set in contact with said ring region up against said second top surface.

17. The device according to claim 15, wherein said active region extends as far as a first level, at least corresponding to said first top surface, and said ring region extends as far as a second level, lower than said first level and corresponding to said second top surface.

18. The device according to claim 15, further comprising a surface region having said first type of conductivity arranged on said first top surface in a position corresponding to and in contact with a body portion of said guard region; said surface region being non-planar, and said second top surface being planar and set in a position corresponding to an end portion of said guard region and to said ring region.

19. The device according to claim 18, wherein said body has a second type of conductivity, opposite to said first type of conductivity; further comprising charge-balance columnar regions having said first type of conductivity and traversing said body, both in said active portion and in said edge portion, and in particular traversing said guard region and said ring region; said surface region comprising surface extensions of said columnar regions on said first top surface, and said columnar regions having a doping level such as to substantially balance an opposite doping level of said body.

20. The device according to claim 19, wherein said surface extensions have a grooved, in particular substantially V-shaped, surface profile.

21. The device according to claim 15, wherein said body has a second type of conductivity, opposite to said first type of conductivity, and said guard region forms with said body a bipolar diode, of which said guard region is the anode and said body is the cathode; further comprising, in a position corresponding to a surface portion of said body distinct from said active portion and from said edge portion, a contact region having said second type of conductivity, for contacting said cathode.